



U.S. Department
of Transportation
Federal Aviation
Administration

DRAFT Advisory Circular

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Subject: UNMANNED AIR
VEHICLE MAINTENANCE

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Initiated by: XXX-XXX

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Change:

1. PURPOSE. This advisory circular (AC) provides information and guidance to the aviation community on the maintenance of unmanned air vehicles (UAVs) used in the National Airspace System (NAS). The guidance provided within this AC pertains to the maintenance of UAVs and their air vehicle control stations (AVCS), and the qualifications, training, experience, and suggested currency criteria for personnel engaged in the maintenance, preventive maintenance, repair, alteration, or inspection of UAVs.
2. EFFECTIVE DATE. This AC becomes effective [insert effective date].
3. RELATED FEDERAL AVIATION REGULATIONS (FAR).
 - a. Title 14 Code of Federal Regulations (14 CFR) part 1, Definitions and abbreviations.
 - b. 14 CFR part 43, Maintenance, preventive maintenance, rebuilding, and alteration.
 - c. 14 CFR part 65, Certification: Airmen other than flight crew members.
 - d. 14 CFR part 91, General operating and flight rules.
 - e. 14 CFR part 145, Repair stations.
 - f. 14 CFR part 147, Aviation maintenance technician schools.
4. RELATED READING MATERIAL.
 - a. AC XX-XX, Unmanned Air Vehicle Design Criteria, dated [insert date].
 - b. AC XX-XX, Unmanned Air Vehicle Operator Qualification and Training, dated [insert date].

- c. AC XX-XX, Unmanned Air Vehicle Operations, dated [insert date].
- d. AC 43-9B, Maintenance Records, dated January 9, 1984.
- e. AC 43.13-1A, Acceptable Methods, Techniques, and Practices - Aircraft Inspection and Repair, dated April 17, 1972.
- f. AC 43.13-2A, Acceptable Methods, Techniques, and Practices - Aircraft Alterations, dated June 9, 1977.
- g. AC 65-12A, Airframe and Powerplant Mechanics Powerplant Handbook, dated April 12, 1976.
- h. AC 65-15A, Airframe and Powerplant Mechanics Airframe Handbook, dated April 12, 1976.

5. BACKGROUND.

- a. Because most UAV operations to date have been conducted by the Department of Defense (DoD) in Special Use Airspace (SUA), there is a lack of data regarding the civilian use of UAVs in the NAS.
- b. New technology raises the prospect of significant growth in the civil UAV industry. Therefore, the Federal Aviation Administration (FAA) has determined a need for criteria and guidance for the maintenance of civil UAVs.
- c. Maintenance practices vary greatly with the design and construction of each unmanned air vehicle. Standard aircraft maintenance practices should be followed to the maximum extent possible. Considerable valuable information can be obtained from the manufacturer of the vehicle and can be used as a basis to establish inspection and repair guidelines. The remotely piloted nature of UAVs makes it more difficult to evaluate in-flight problems; therefore, a sound maintenance program is vital to the safe operation of UAVs.
- d. In its initial review of UAV operations, the FAA has determined that UAVs are sufficiently different from normal category airplanes certificated under the provisions of 14 CFR parts 21 and 23 to be considered a "special class" of aircraft under 14 CFR § 21.17. This determination is consistent with the definition of "class" found in 14 CFR § 1.1 and used with respect to the certification of aircraft.
- e. The FAA has determined that it is premature to impose regulatory criteria on UAVs at this time. However, the FAA believes that the voluntary adoption of the guidance contained in this AC will maintain safety levels and increase public

confidence without imposing an undue cost during the period in which civil UAV operations in the NAS are conducted on a single-event basis.

6. DEFINITIONS. The following terms have the meaning listed when used in this AC.

a. Air Vehicle Control Station (AVCS). A flight deck on the ground without external flight environment cues used for the control of a UAV.

b. Autonomous Operation. A preprogrammed, automated flight profile that does not require human intervention for normal operation.

c. Built-In Test. A set of procedures performed internally by UAV systems to determine the degree of functionality of critical systems or components.

d. Catastrophic Failure. Any failure that leads to loss of the UAV and endangers people and/or property (i.e., a failure that prevents continued safe flight and landing).

e. Collision Avoidance Lighting. Lights or other visibility enhancements installed on a UAV that make the UAV easier to see and avoid in flight.

f. Crew Chief. The person responsible for completion of the pre-flight inspection and the post-flight inspection.

g. Critical Failure. Any failure that leads to UAV mission termination.

h. Critical System. A system or systems, the loss or malfunction of which would lead to a critical or catastrophic failure.

i. External Pilot. A UAV pilot who, in the absence of full automatic launch and recovery systems, visually controls the UAV flight path, generally during launch and recovery, from a site that provides direct visual contact with the UAV.

j. Flight Termination System. A controllable parachute or automatic preprogrammed course of action used to terminate flight in case of a catastrophic failure.

k. Internal Pilot. A UAV pilot who operates the UAV from a site that does not necessarily provide direct visual contact with the UAV. The internal pilot normally operates the UAV by means of commands sent to the UAV by radio link. Vehicle status and navigation information is received from the UAV via radio link.

An internal pilot also may consist of a hardware and/or a software system on board the UAV capable of providing flight path control inputs to the vehicle based on real-time environmental, system health/status, or tasking inputs; however, a ground-based internal pilot is responsible for monitoring autonomous operations.

l. Post-Flight Inspection. A set of functional tests of UAV systems and components, usually closely following the manufacturer's recommended tests or checklists, performed immediately upon the conclusion of each UAV mission.

m. Pre-Flight Inspection. A set of functional tests of UAV systems and components, usually closely following the manufacturer's recommended tests or checklists, performed before each launch of a UAV.

n. Propulsion System. A system comprised of those components necessary to ensure the safe propulsion of the UAV.

o. Skill Levels. General eligibility requirements recommended by the UAV manufacturer, formal classroom education, and approved apprenticeships needed to be completed in order to perform inspections, maintenance, and repair of a UAV.

p. Unmanned Air Vehicle (UAV). An air vehicle that does not carry a human operator, and is capable of flight beyond visual line of sight under remote or autonomous control for civil (non-DoD) purposes. A UAV is considered nonexpendable if engaged in operations other than hazardous or oceanic meteorological observation operations.

7. GENERAL. For purposes of determining UAV airworthiness, the air vehicle and all support equipment, including any ground control, telemetry, or monitoring equipment, should be considered components of the UAV system. The recommendations of this AC apply equally to each component of the UAV system.

8. PERSONNEL.

a. Training and Skill Level. Inspection, maintenance, and repair personnel should have an established skill level sufficient to safely perform the functions of their position. This could include a mix of formal and informal training, including on-the-job training. Personnel performing maintenance should have experience in working on aircraft and aircraft systems.

b. Currency. The UAV operator should establish training, experience, and currency requirements for its maintenance and

inspection personnel. The currency requirements should be established such that the training curriculum has been completed prior to performing tasks and/or the person has had apprenticeship/work experience in the task area within the previous 24 months.

c. Crew Chief. A crew chief should be assigned responsibility for the system's functionality and performance for each UAV mission.

9. MANUFACTURER GUIDANCE.

a. For each model of UAV produced, the manufacturer should develop, prepare, and provide to the operator, and the operator should maintain, manuals containing the following recommended procedures:

(1) Inspection Procedures. Pre- and post-flight inspection procedures, including the frequency of inspections, a listing of necessary equipment, and the skill levels necessary to perform the inspections.

(2) Maintenance Procedures. Diagnostic procedures and procedures for the repair and replacement of components, including a listing of necessary equipment and the skill levels required to perform the procedures.

(3) Repair Station Procedures. Recommendations on the minimum and preferred tools for field and base facilities.

(4) In-Flight Diagnostics Procedures. Mission abort thresholds and recommended actions for in-flight systems' shutdown and return to base.

b. It would be expected that, at least for some initial period, the manufacturer of each UAV should provide vehicle-specific maintenance and inspection training.

10. GENERAL MAINTENANCE GUIDELINES.

a. Maintenance and repair of UAVs should follow the guidance given in AC No. 43.13-1A and AC No. 43.13-2A, unless indicated otherwise in this AC.

b. Maintenance of UAVs and ground control equipment should be governed by the manufacturer's recommended periods of inspection and overhaul as applicable.

11. RECORDKEEPING.

a. For each UAV, a log book should be maintained. In this logbook, the UAV operator should maintain records of all maintenance actions performed on that specific UAV. Notes should be made of every action showing compliance with any applicable maintenance directives.

b. For each UAV, a discrepancy log should be maintained, indicating any discrepancies found during any preflight or post-flight inspection, and the status of corrective action taken.

c. Each part used in UAV repair and maintenance should be documented to meet the manufacturer's or operator's specifications, whichever are more stringent. It should be the crew chief's responsibility to certify that each part or material incorporated into a UAV structure or used in UAV repair meets or exceeds these specifications. The crew chief should maintain a log of all parts used in UAV maintenance and repair. This log should be sufficiently detailed to allow tracing of each item used in maintenance or repair of the UAV to the manufacturer of that item, as well as a lot or batch identification of that item.

12. BUILT-IN TEST.

a. Each aircraft should provide for access, either in the form of an aircraft mounted display or a plug-in type display, to an internal set of software procedures designed to exercise critical components and systems, and provide a state of system health. This information should be available to the pilot operating the UAV during flight.

b. Also included should be a set of diagnostic procedures to aid fault location. For in-flight use, these procedures should include the amount of emergency power reserve remaining.

13. COLLISION AVOIDANCE SYSTEM (CAS). The CAS on board each UAV, if installed, should be exercised prior to each flight in accordance with manufacturers' recommended procedures.

14. FLIGHT TERMINATION SYSTEM (FTS).

a. The FTS, if installed, should be inspected in accordance with manufacturers' instructions prior to and immediately following each flight.

b. A qualified Crew Chief should be responsible for preparing, engaging, and disarming an FTS for each flight.

c. The FTS should undergo an inspection at an FAA-certificated repair station or manufacturer's recommended facility on a schedule recommended by the manufacturer.

15. PRE-FLIGHT INSPECTION.

a. The pre-flight inspection should be a thorough examination of the UAV's safety-critical systems and mission-critical systems to determine that the UAV is capable of completing its mission safely. It should be the crew chief's responsibility to certify that the UAV is safe to fly the planned mission. Failure of any safety-critical or mission-critical UAV system to perform to this level of capability should result in cancellation of the flight.

b. Any additional manufacturer-recommended pre-flight actions for other systems should also be performed in accordance with those specified.

c. Any discrepancies that result in cancellation of a flight, or that, if not corrected, could have an impact on the safety of a mission, should be entered in the discrepancy log.

16. POST-FLIGHT INSPECTION.

a. The post-flight inspection should be a thorough examination of all UAV systems to determine that the UAV has not experienced any unusual wear or damage in the mission just completed, and that the performance of all UAV systems remains within the manufacturer's or operator's specifications, whichever are more stringent. It should be the crew chief's responsibility to conduct the post-flight inspection. Failure of any system to perform to this required level of capability should result in the removal of the UAV from service until appropriate maintenance and repair actions are completed and subsequent inspection by the crew chief determines that all UAV systems are performing within the manufacturer's or operator's specifications, whichever are more stringent.

b. Any additional manufacturer-recommended post-flight actions for other systems should also be performed in accordance with those specified.

c. Any discrepancies that ground the UAV until corrected, or that could have an impact on the safety of a mission, should be entered in the discrepancy log.

17. ADDITIONAL GUIDANCE. Operators of UAV designs, and operators of UAVs engaged in applications that, because of mission requirements or hazardous conditions, cannot comply with the suggested training criteria specified in this AC, should contact the nearest FAA Regional Office for further information and guidance.

18. COMMENTS INVITED. Comments regarding this publication should be directed to:

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